Cost-effectiveness of a targeted disinfection program in household kitchens to prevent foodborne illnesses in the United States, Canada, and the United Kingdom


Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The use of a disinfection programme targeted at household kitchens to prevent foodborne illnesses in the USA, Canada, and the UK. The analysis assumed that disinfection practices would be implemented for one year.

Type of intervention
Primary prevention.

Economic study type
Cost-utility analysis.

Study population
The study population comprised all households in the USA, Canada and the UK. There was also a sub-group of households including at least one member at high risk of acute infection or chronic sequelae (defined as those aged under 5 years, older than 65 years, or immunocompromised).

Setting
The study setting was the community. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1997 and 2003. The price year was 2001.

Source of effectiveness data
Epidemiologic and quality of life estimates for the analysis were obtained from published literature, unpublished data, or an expert panel.

Modelling
The authors developed a spreadsheet-based model to assess the number of cases of foodborne illnesses likely to be prevented by implementing targeted disinfection practices in household kitchens and to estimate the cost-effectiveness of the intervention. Though the change in disinfectant practices was modelled for one year, the clinical, quality of life and cost outcomes were modelled for 30 years.

Outcomes assessed in the review
The outcomes assessed were:

the annual cases of infection in the USA, Canada and the UK due to salmonella, campylobacter and Escherichia coli
infection;
the proportion of infections attributable to foodborne cases;
the proportion of foodborne infections occurring in the household setting;
the percentage of households substituting disinfection products for current cleaning products;
the percentage of households adding disinfection products to current cleaning products; and
the average amount of disinfectant used per year per household.

Study designs and other criteria for inclusion in the review
Not reported.

Sources searched to identify primary studies
MEDLINE, HealthSTAR, EMBASE, and Food Science and Technology Abstracts were searched for relevant literature using keyword terminology for foodborne illnesses. The reference lists from retrieved articles were also checked. In addition, the authors reviewed published reports and statistics listed on Government websites in the USA, Canada and the UK.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
Approximately 10 primary sources were included in the review.

Methods of combining primary studies
Not applicable.

Investigation of differences between primary studies
Not applicable.

Results of the review
The numbers of annual cases of salmonella infection in the USA, Canada and the UK were 1,412,498, 274,350 and 54,400, respectively.

The numbers of annual cases of campylobacter infection in the USA, Canada and the UK were 2,453,926, 554,900 and 486,400, respectively.

The numbers of annual cases of Escherichia coli infection in the USA, Canada and the UK were 73,480, 30,380 and 3,000, respectively.

The proportions of infections attributable to foodborne causes because of salmonella, campylobacter and Escherichia coli infections were 90%, 90% and 85%, respectively.
The proportions of foodborne infections that occur in the household setting because of salmonella, campylobacter and Escherichia coli infections were 50%, 50% and 80%, respectively.

The percentage of households substituting disinfection products for current cleaning products was 67%.

The percentage of households adding disinfection products to current cleaning products was 33%.

The average amount of disinfectant used per year per household was 183 oz in the USA, and 5,475 mL in Canada and the UK.

Methods used to derive estimates of effectiveness
The authors supplemented data from the literature with expert opinion to estimate the possible efficacy of targeted cleaning practices in the household setting, as well as best- and worst-case efficacy estimates. The utility data for each of the possible health states were also derived from the panel of five clinical and food safety experts.

Estimates of effectiveness and key assumptions
The proportions of household salmonella, campylobacter and Escherichia coli infections attributable to cross-contamination in the kitchen were 20%, 30% and 40%, respectively.

The proportion of household salmonella, campylobacter and Escherichia coli infections attributable to surface cross-contamination in the kitchen was 50% for the three infections.

The proportions of household salmonella, campylobacter and Escherichia coli infections attributable to surface cross-contamination in the kitchen that are possibly preventable with disinfection procedures were 33%, 33% and 25%, respectively.

Measure of benefits used in the economic analysis
The measure of benefits used was the quality-adjusted life-years (QALYs) gained. To obtain utilities for the 13 health states in the analysis, the authors provided a narrative describing the usual symptoms associated with each health state to the expert panel. The panellists assigned distress and disability ratings to each health state using the method developed by Rosser and Kind. The experts also assigned the average duration of each health state.

Direct costs
The resource quantities and the costs were not reported separately. The direct costs included in the study were those of the health care service. These were for physician office visits, outpatient and emergency room visits, medication, and hospitalisations due to each of the three diseases. When available, the authors used published studies to estimate the costs per case for acute infections and chronic sequelae. When suitable country-specific cost estimates were not available in the literature, the authors used one of two approaches. First, to estimate the direct medical costs of acute infection in Canada and reactive arthritides in the USA, clinicians enumerated resource use associated with the illnesses, and unit costs were then assigned on the basis of country-specific reimbursement schedules. Second, when published US estimates were available for chronic conditions, the authors converted these estimates to Canadian dollars or British pounds by purchasing power parities. The authors also included the costs of the targeted disinfection programme (by estimating the extra household products that would be required), in addition to current cleaning products. The data needed were the proportion of households substituting versus adding disinfection products, annual disinfectant use, and the national average purchase prices of disinfectant and non disinfectant products. As the costs were incurred over a 30-year period, all future costs were discounted at an annual rate of 3%. The price year was 2001.

Statistical analysis of costs
The costs were treated as point estimates (i.e. the data were deterministic).
Indirect Costs
The study included the indirect costs associated with productivity losses for the three foodborne infections. The authors used published studies estimating the indirect costs per case for acute infections and chronic sequelae. When suitable country-specific cost estimates were not available in the literature, the authors used one of two approaches. First, to estimate productivity losses associated with acute infection in Canada and reactive arthritides in the USA, clinicians enumerated resource use associated with the illnesses. Second, when published US estimates were available for chronic conditions, the authors converted these estimates to Canadian dollars or British pounds by purchasing power parities.

Currency
Canadian dollars (Can$), US dollars ($), and UK pounds sterling (£). When the costs had to be converted from US dollars to Canadian dollars or UK pounds sterling, the authors used purchasing power parities.

Sensitivity analysis
The external validity and generalisability of the results were assessed by performing one-way sensitivity analyses and several other analyses, in which multiple parameters were varied over plausible ranges. Sensitivity analyses were conducted to determine the consequences of making alternative assumptions about the total number of cases prevented, foodborne illness incidence rates, the inclusion of chronic sequelae, the cost of the disinfection programme, the cost of foodborne illnesses and the utility estimates.

Estimated benefits used in the economic analysis
The total number of QALYs gained when the disinfection programme targeted the whole population was 15,845 in the USA, 3,452 in Canada and 2,182 in the UK.

The total number of QALYs gained when the disinfection programme targeted only high-risk households was 10,367 in the USA, 2,259 in Canada and 1,427 in the UK.

Cost results
The total cost of prevented cases (including productivity losses) due to the disinfection programme involving the whole population was $239,865,452 in the USA, Can$63,103,902 in Canada and 33,563,502 in the UK.

The total cost of the disinfection programme involving the whole population was $788,428,650 in the USA, Can$111,556,947 in Canada and 205,288,100 in the UK.

The total cost of prevented cases (including productivity losses) due to the disinfection programme involving only high-risk households was $157,618,301 in the USA, Can$41,207,218 in Canada and 22,064,302 in the UK.

The total cost of the disinfection programme involving only high-risk households was $197,107,163 in the USA, Can$27,889,237 in Canada and 51,322,025 in the UK.

Synthesis of costs and benefits
The costs and benefits were combined using an incremental cost-utility ratio (i.e. the additional cost required for every QALY gained).

In the USA, the incremental cost-utility ratio associated with the disinfection programme targeting the whole population was US$41,021 per QALY gained. When this programme only involved the high-risk population, the incremental cost-utility ratio was $10,163 per QALY gained.

In Canada, the incremental cost-utility ratio associated with the disinfection programme targeting the whole population was Can$21,950 per QALY gained. When this programme only involved the high-risk population, the incremental cost-utility ratio was Can$1,915 per QALY gained.
In the UK, the incremental cost-utility ratio associated with the disinfection programme targeting the whole population was 86,341 per QALY gained. When this programme only targeted the high-risk population, the incremental cost-utility ratio was 28,158 per QALY gained.

Although the results did vary when incidence rates, foodborne illness costs, chronic sequelae costs, programme costs, and patient utilities were varied in the sensitivity analyses, the changes were not substantial enough to alter the authors’ conclusions. However, the results were very sensitive to the number of illness cases that might be prevented by the disinfection programme. When the most conservative variable estimate was used there was a five-fold increase in the cost-effectiveness ratio. When the least conservative estimate was used, implementing the disinfection programme resulted in lower costs and better effectiveness in the US and Canada, and a low incremental cost-utility ratio (6,359 per QALY) in the UK.

Authors’ conclusions
The implementation of a disinfection programme targeted at household kitchens in the USA, Canada and the UK would appear to be a cost-effective strategy.

CRD COMMENTARY - Selection of comparators
The use of no disinfection programme to prevent foodborne illnesses as the comparator was justified, as this represents current practice in the UK, US and Canada. However, the authors should have been more explicit on what the intervention (i.e. the targeted disinfection programme) entailed, as it was not very clear how the intervention would be put into practice from this study. You should decide if the comparator used represents current practice in your settings.

Validity of estimate of measure of effectiveness
The authors performed a systematic review of the literature by including data from governmental, published and unpublished sources. The authors clearly reported all the sources used to identify relevant literature. When data was not available from the literature, the authors consulted an expert panel of five clinicians and food safety experts to derive the effectiveness of the intervention at reducing foodborne illnesses and to derive quality of life estimates. The critical effectiveness data were actually derived from an expert panel, which means that the model was based on uncertain data. All assumptions and literature estimates used in the model were appropriately investigated in sensitivity analyses, using ranges that appear to have been appropriate.

Validity of estimate of measure of benefit
The estimation of benefits was modelled using a spreadsheet model, which was appropriate. The utilities were estimated by the expert panel using an established method. The utility values were varied in the sensitivity analyses.

Validity of estimate of costs
It would appear that all the categories of cost relevant to the societal perspective adopted were included in the analysis. However, as these costs were obtained from the published literature or expert opinion, and not much detail was given, it was unclear whether all the relevant costs were included in the analysis. The costs and the quantities were not reported separately, which will limit the generalisability of the authors’ results. The costs were derived from published literature, expert opinion, or extrapolations from the USA to the UK and Canada. Owing to the systematic variations between health care systems in these three countries, it is unclear if extrapolations between countries are valid and will reflect the true cost of the disease in Canada and the UK. Although the authors tried to adjust for differences in health care expenditure using purchasing power parities, it is very likely that this will not be sufficient. The costs were investigated in a sensitivity analysis, using ranges that appear to have been appropriate. Since some costs were incurred over 30 years, future costs were appropriately discounted. The price year was reported, which will aid any future inflation exercises.

Other issues
The authors reported that their study was the first analysis to quantify the potential value of a targeted disinfection programme. The issue of generalisability to other settings was addressed in the sensitivity analysis, and by assessing the cost-effectiveness of the disinfection programme in three different countries. The authors do not appear to have presented their results selectively. The authors concluded that a targeted disinfection programme should be implemented in the UK, even though it was associated with an incremental cost-utility ratio of 86,341 per additional QALY, which represents poor value for money. Even though the authors pointed out that the cost of the disinfection programme would be borne by consumers and not the National Health Service, it is unlikely that with such a high incremental cost-utility ratio this programme could be instituted in the UK.

The authors reported several further limitations to their study. First, they made numerous assumptions in their model. Second, only the three most common bacterial foodborne illnesses were included. Hence, the results could be viewed as conservative as the programme could prevent other illnesses. Third, the authors pointed to some limitations when estimating quality of life. Fourth, only the household setting was considered, even though a significant number of foodborne illnesses could arise in other kitchen settings (e.g. schools, restaurants, hospitals). Finally, the authors did not consider the adverse effects that detergents and disinfecting products might have.

Implications of the study
The authors appeared to recommend the use of a disinfection programme in household kitchens, especially in those with at high-risk individuals.

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Other publications of related interest


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